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To what South Korea Owes Success in Innovations?
Implications for Turkey

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Introduction

South Korea managed to be an attention-attracting country with its success in economic development and the striking advance it made in the fields of innovation and R&D. S. Korea which performed worse than Turkey in terms of per capita GDP and R&D activities until 1980s completely reversed this situation from that point on and achieved not only considerable growth performance but also an impressive technologic advance. Owing to the attempts in innovations, skill development and the importance attached to human resources, the country succeeded in overcoming the 'middle-income trap'[1] which is commonly accepted to be one of the biggest challenges facing developing countries today. At the heart of this success lie the critical steps devoted to securing a position to compete with developed countries and certain transformation processes the country went through. The most important feature of the mentioned transformation processes is the development of an R&D system, while the investments in education proves to be one of the most significant factors facilitating this. This study examines the changes in the industrial strategy and science and technology policies in S. Korea and carries out a comparative analysis as to how Turkey performed and advanced in similar processes of change. The advance of the R&D system plays a crucial role in the sectoral change and rapid economic growth of S. Korea. The significant rise in R&D expenditures as well as rapid transition to high value-added high-tech products in production and exports since the 1980s reinforced the improvements in the R&D system. Then, how could the advance of the R&D system made such a rapid contribution to sectoral change and economic development? It is among the purposes of this study to analyze the factors that can provide an answer to this question, in comparison with Turkey.

Industrial strategy and R&D policy from 1960s to present: S. Korea and Turkey

Before examining in deep the sectoral and technological change witnessed by S. Korea and Turkey as well as respective innovation and R&D systems it will be of use to take a look at the course of innovation and R&D processes in both countries from 1960 to present. The development of innovation and R&D system of S. Korea can be classified under three main processes: Imitation Process (1960s and 1970s), Transformation Process (1980s) and Innovation Process (1990s onwards).[2] In the imitation process, labor-intensive sectors were at the fore and industrialization process was facilitated by foreign direct investments and technology transfers. In the transformation process where the influence of import substitution and protectionism started to fade out, it was decided that technology transfers and research by universities and public institutions alone were insufficient and thus the private sector was encouraged to establish and develop its own R&D structure. In the third process, the innovation process, S. Korean government, along with the Asian crisis that become visible particularly by the second half of 1990s, felt the urge to shift technology policies from large industrial firms prioritized until then to relatively more flexible, dynamic and innovative SMEs. To put it differently, along with the innovation process and particularly following the Asian crisis, small-scale

[1] According to World Bank's definition, countries in the "middle-income trap" are those lost competitiveness in Standard manufacturing goods against low-labor cost poor countries while having difficulty in achieving a convergence with innovation-led rich countries.

[2] OECD Reviews of Innovation Policy, Korea (2009)

R&D centers and technology-based small firms gained importance[3] which was represented also by the rise in R&D expenditures and intensities of SMEs.

Table 1. Industrial, science and technology policies from 1960s to present

		1960-1980	1980-1990	1990-2000	2000 onwards
South Korea	**Science and Technology Policies**	• Establishment of the first state-owned research institute Korean Institute of Science and Technology (KIST) and Ministry of Science and Technology • Enactment of the first Technology Incentive Law (1967) (tax exemptions)	• National R&D Program (1982) • Foundation of 'Deadeck Science Town' • R&D incentives or private firms (tax incentives, financial incentives)	• Formation of National Council of Science and Technology • Five-year innovation plan • Science and Technology Vision 2025 (1999) • Research incentives for universities	• Preparation of the first national technology roadmap • Restructuring of the Ministry of Science and Technology
	Outline of the Industrial Policy	• **1960s:** development of import substitution industries, dominance of agriculture and textile sectors owing to cheap labor • Foreign direct investment and technology transfers • **1970s:** Shift to heavy industry • Incentives to improve domestic R&D capacity	• Shift to technology intensive sectors • Technology transfer and research institutes proving insufficient alone, incentives for firms to establish and develop R&D structures of their own	• Development of high-technology sectors • Enhancement of demand-driven technology development system • Regulations and revisions about firm structure following the Asian crisis	• Shift to biotechnology and nanotechnology along with the advance in the existing high technology sectors • Generalizing of R&D oriented SMEs different than the traditional SME structure
Turkey	**Science and Technology Policies**	• Establishment of TUBITAK, MAM under its body as well as the Science and Technology Department under the body Ministry of Industry and Trade • Highlighting of the importance of domestic technology development (3rd Development Plan)	• Foundation of Higher Board of Science and Technology • Addressing of technology policies for the first time in a development plan(4th plan) • Referral to the importance of technology transfer (5th Development Plan)	• Establishment of TTGV (1991) • Establishment of Turkish Patent Institute (1994) • Highlighting of the importance of R&D activities, importance of using information technologies (7th Development Plan)	• Importance of establishing and promoting university-state-private sector partnerships (8th Development Plan) • Significance of developing infrastructure for information and communication technologies (9th Development Plan)
	Outline of the Industrial Policy	• Development of import substituting industries • Shift from labor intensive low technology industries to medium-technology industries (as also anticipated by Development Plans)	• Export-oriented growth strategy; turn back to low-technology products relying on labor intensive sectors and cheap labor	• Jump back to medium-technology sectors; slow course	• Focus on the importance of medium- and high-technology growth strategies

Source: Compiled from Turkey Five Year Development Plans, OECD Reviews of Innovation Policy, Korea (2009) and Models for National Technology and Innovation Capacity Development for Turkey, TTGV, 2009 reports.

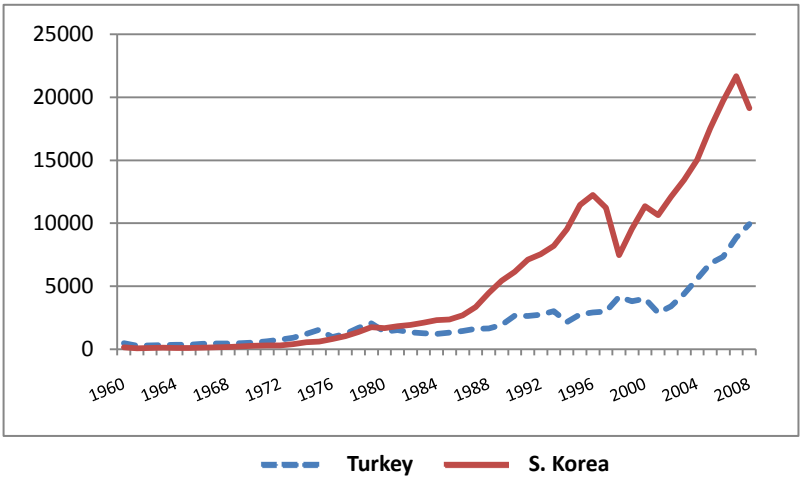
In Turkey, attempts to introduce science and technology policies become visible in 1960s during the shift to planned economy period.[4] Although the mentioned plans frequently referred to science and technology policies, however, Turkey could not take as solid steps as in S. Korea. The table above shows in brief the developments in S. Korea and in Turkey and the resultant science and technology policies as well as industrial strategies.

[3] Models for National Technology and Innovation Capacity Development for Turkey, TTGV, 2009
[4] Çalışır and Gülmez, Güney Kore'nin Başarısının Arkasındaki Arge Gerçeği ve Türkiye ile Bir Karşılaştırma (2007)

Overview of changes in economic structure: S. Korea and Turkey

From early 1960s to 1980s, per capita GDP was high in Turkey than S. Korea. In 1965 where the difference was the largest, per capita GDP in Turkey equaled 3.5 times that in S. Korea. Nonetheless, beginning with 1980s this picture was reversed. The difference has widened in advantage of S. Korea; as of 2007 Turkey's GDP per capita is US$8,874 whereas S. Korea's GDP is 2.5 times that of Turkey's at US$21,653.

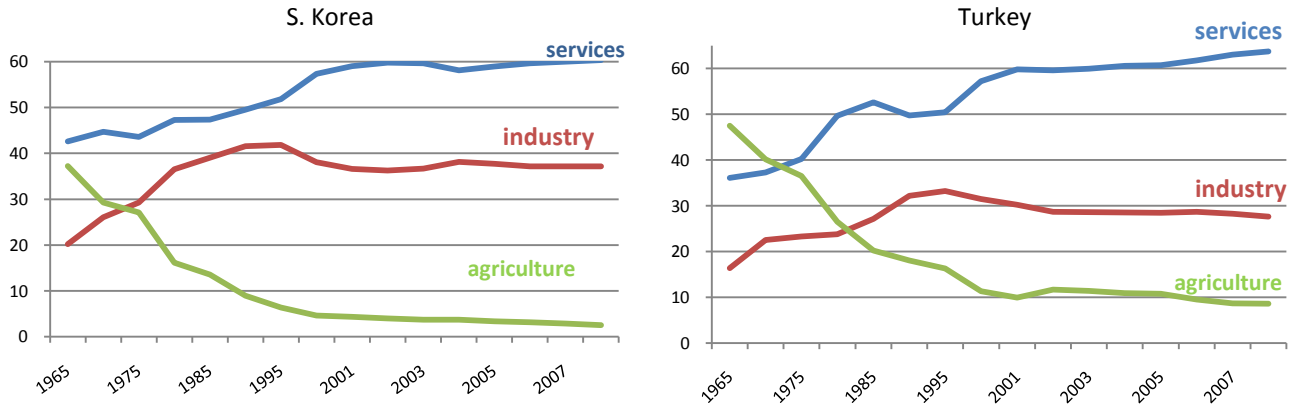
Figure 1. Change in per capita GDP in S. Korea and Turkey (1960-2008)



Source: World Bank, World Development Indicators

Similarly, sector structure of the two countries were similar in 1960s and 1970, a substantial divergence occurred beginning with 1980s. As the Figure 2 below suggests, agricultural and services sectors were dominant in both Turkey and South Korea during 1960s. By 1965, share of agricultural sector in S. Korea started to decline steeply. A rapid industrialization process took place in S. Korea as of 1970s, thanks to which the share of industrial sector in GDP reached as high as 40% in 1990s. For Turkey the highest rate recorded for the share of industrial sector is 30% achieved in 1995.

Figure 2. Comparison of sector structures in Turkey and S. Korea (% GDP)

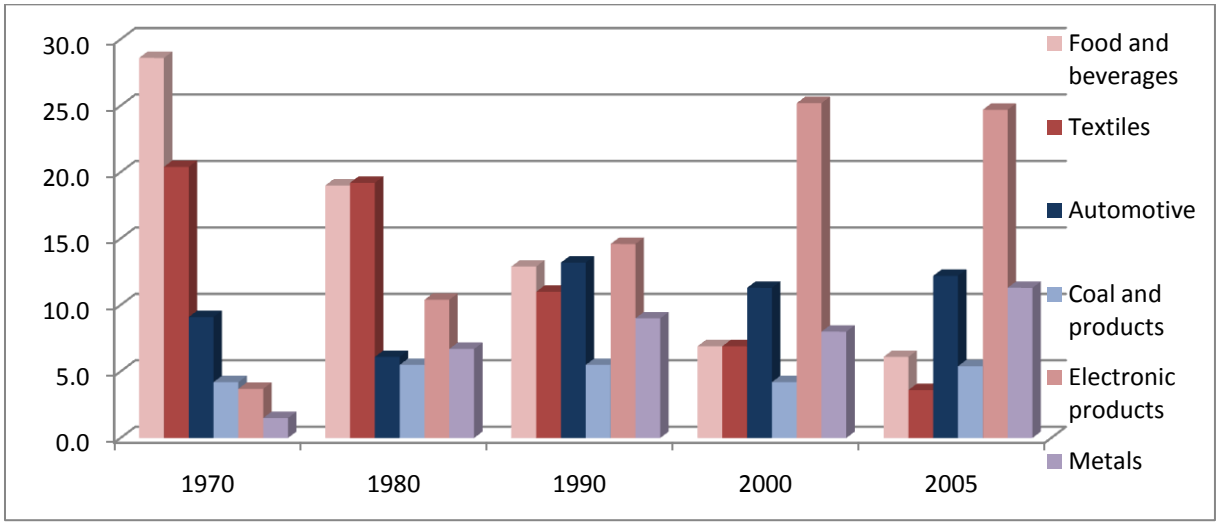


Source: World Bank, World Development Indicators

Structure of manufacturing industry in S. Korea and Turkey

Composition of manufacturing sector of S. Korea has also witnessed significant changes. The Figure 3 below reveals a rapid change from labor-intensive industry including food, beverages and textiles to capital-intensive light industry and then to high-tech industry involving information technologies.

Figure 3. Changes in the share of sectors in GDP, S. Korea, %



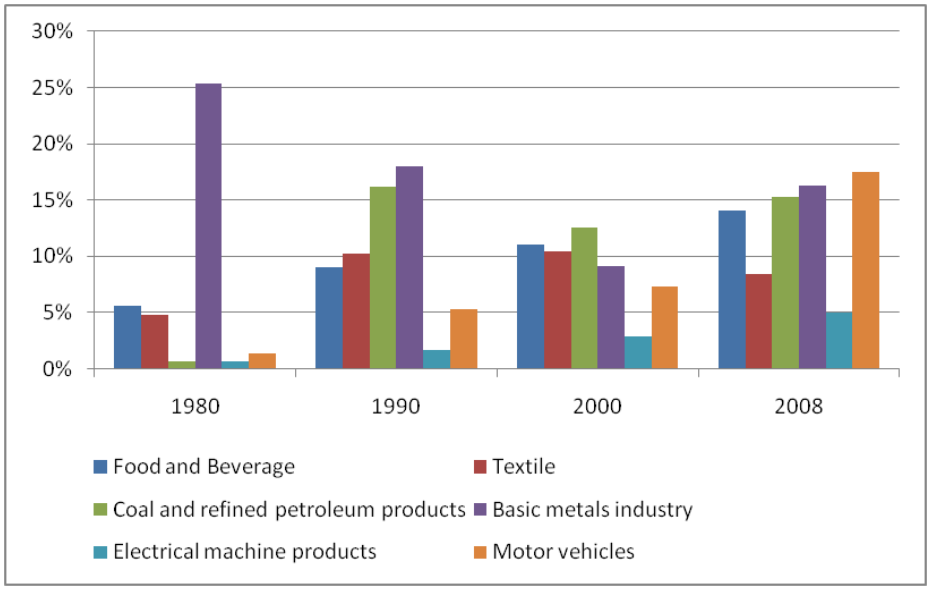
Source: Bank of Korea, national accounts and statistics (The figure represents 6 out of 10 leading industrial branches that lead industrial production).

From 1990s to early 2000, the share of electrical and electronics goods increased from 15 to 25 percent. Over the same period the gap between the share of the said sectors and low-tech labor intensive food, beverages and textiles sector, which dropped below 5%, widened significantly and the dominance of the sectors requiring high technology gained prevalence. The mentioned process validates the innovation, Information and Communication Technologies (ICT) and R&D activities which gained dominance in the context of the 'Innovation Process' in S. Korea as mentioned earlier. One point to underline in this frame is that implementation of R&D policies upon strategic decisions after selection of focus sectors is one of the major factors that influenced the technological structuring and development of S. Korea. Special importance attached to the ICT in the aftermaths of the crisis sets a good example in this respect.[5] Desired outcomes can be attained more quickly should focus groups are selected and policies are implemented in this direction. Indeed, the contribution the ICT sector made to GDP growth reached as high as 45% in 2000.[6] Similarly, between 1995 and 2006, the share of ICT sector in manufacturing industry increased from 16 to 21.1 percent. The rise by 5.1 points becomes even more impressive when 0.3 percent OECD average over the same period is considered.

Examination of Turkey's manufacturing sector indicates that the sector making the largest leap since 1980 is the motor vehicles sector (Figure 4). To put it differently, S. Korea enabled rapid switch to high technology and information technologies whereas Turkey went through a direction towards medium-technology sectors.

[5] OECD Reviews of Innovation Policy, G. Korea (2009)
[6] ESCAP, G. Korean Experience of Overcoming Economic Crisis through ICT Development (2009)

Figure 4. Share of sectors in GDP by years, Turkey, %



Source: TURKSTAT and TEPAV Calculations (based on the composition of Industrial Production Index)

Technology content of exports: S. Korea and Turkey

In the 1980-1990 period, both Turkey and S. Korea implemented export oriented industrialization strategy. Nonetheless, S. Korea has realized the significance of high-technology based growth and managed altering the composition of exports to this end. Turkey, on the other hand, sustained an export strategy based on labor-intensive sectors and thus failed to preserve competitiveness. As Figure 5 suggests, the comparison of the two countries with respect to the share of exports in GDP represent a similar result with that of per capita GDP levels. This is another factor useful in explaining the GDP gap between S. Korea and Turkey. Furthermore, Figure 6 shows clearly the difference between the two countries concerning the share of high-technology products in total exports. Shift towards high-technology products in S. Korea enabled the alteration of the export composition and widened the gap in GDP in exports against Turkey.

Figure 5. Share of exports in GDP (%)

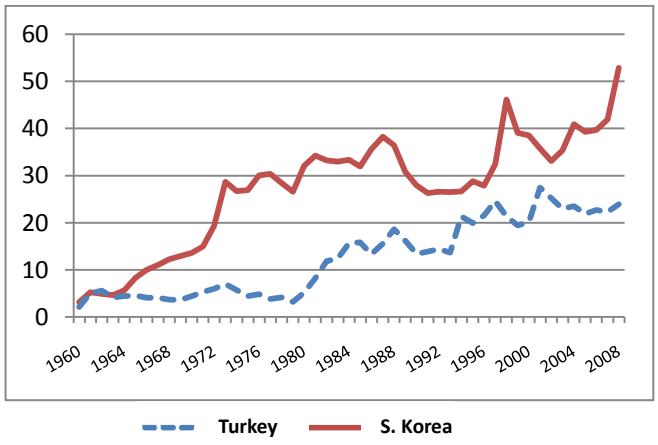
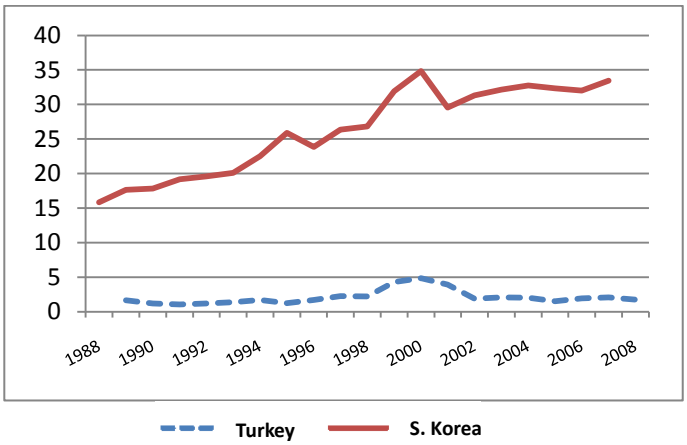


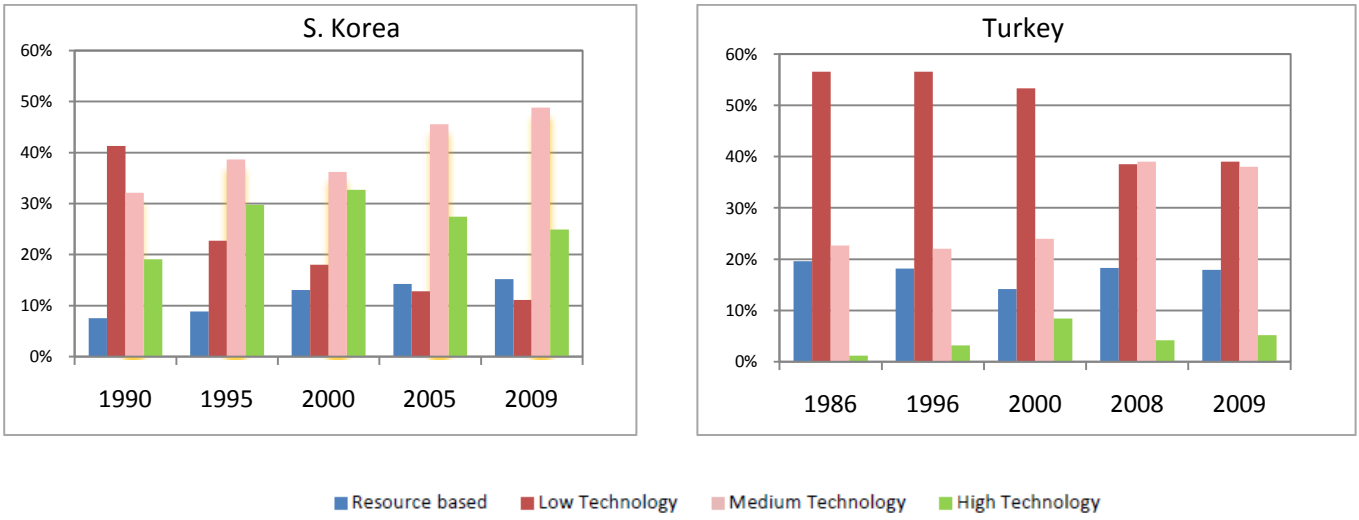
Figure 6. Share of high-tech exports in total exports (%)



Source: World Bank, World Development Indicators

If the technology content of export goods in both countries is analyzed (Figure 7), it is seen that in S. Korea a steep fall in the low-technology sectors has been witnessed since 1990. Similarly, the rise in medium-technology sectors has become apparent. In Turkey, though the share of medium- and high-technology goods has tended to increase since 1986, low-technology products still preserve their dominance.

Figure 7. Technology content of export goods: Comparative, S. Korea and Turkey



Source: COMTRADE database, TEPAV calculations (UNIDO technologic classification of goods was taken as basis)

How the advance of the R&D system could make such a rapid contribution to sectoral change and economic development?

The biggest contribution to sectoral change and thus rapid economic growth in S. Korea was made by imitation, transformation and innovation processes as well as the development of the R&D system.[7] Then, how could the advance of the R&D system made such a rapid contribution to sectoral change and economic development? Some points should be highlighted in this regard first of which is related with the change in the shares of public and private sector R&D activities.

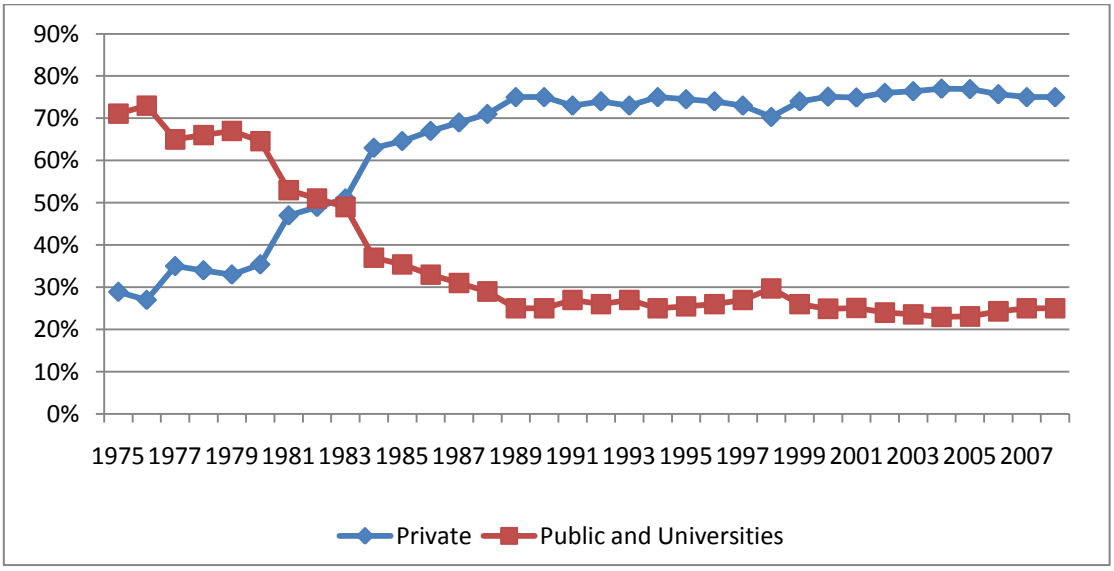
- *Does Turkey experience the S. Korea's private and public sector R&D transformation of 1980s only in the recent years?*

In S. Korea share of private sector in overall R&D stood at 30 percent in 1970s whereas as of 1976 share of public sector tended to fall and of private sector tended to rise. By 1983, private sector carried out 50% of overall R&D and the upwards trend in the share of private sector R&D prevailed from that point on. As data for 2008 suggests, the picture is the exact opposite of that in 1970s where currently private sector carries out 75% of the R&D. furthermore, as Figure 9 reveals the share of

[7] Shin et al. (2006), Effects of R&D investment on economic growth and income distribution, Ministry of Science and Technology.

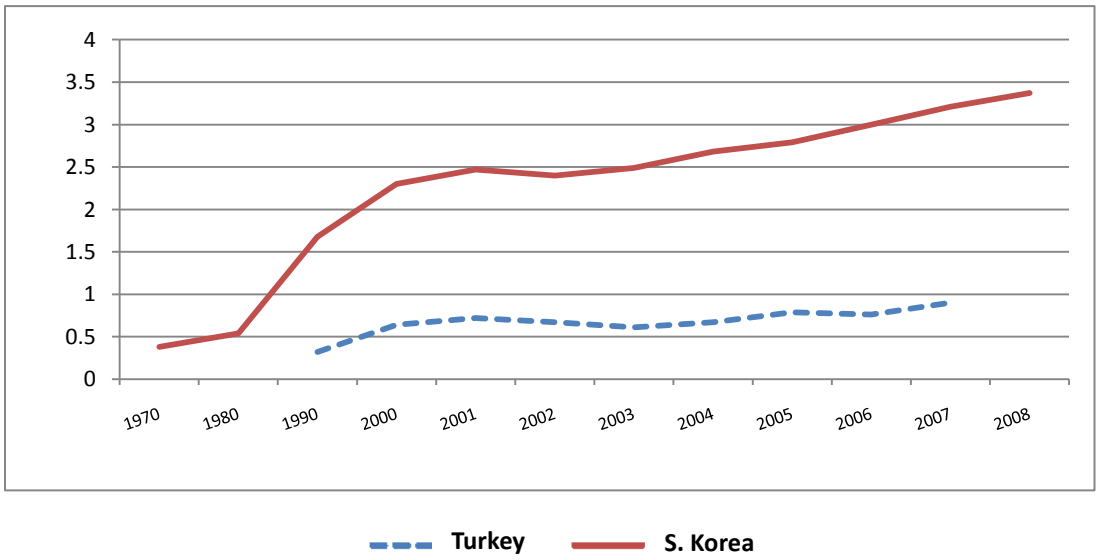
R&D expenditures in GDP doubled from 1980 to 1985. But the critical point here is the domain and efficiency of expenditures. As of 1980, increase in private sector's R&D activities contributed to the rise in total R&D expenditures while contributing as well to economic growth through product development, commercialization of developed products and entering in international markets.

Figure 8. Change in the share of public and private sector in R&D in S. Korea, by years (1975-2008)



Source: MoST and KISTEP (2006), Report on the survey of Research and Development in Science and Technology, Ministry of Science and Technology.

Figure 9. Change in the share of R&D expenditures in GDP



Source: S. Korea Ministry of Science and Technology and TURKSTAT R&D Statistics.

In the period before 1980 which is defined as the imitation process above, S. Korea aimed to transfer foreign technologies and establish the environment suitable for such transfer in order to change the export composition. However on the eve of 1980s, the government has realized that technology transfer alone will not ensure the sustainability of growth and that development of a domestic R&D system is crucial. In this context, public institutes devoted to develop domestic R&D capacity were

established and then a number of measures and subsidies were introduced in order to support and facilitate R&D activities by the private sector. R&D activities by the private sector contributed to the creation of value added.

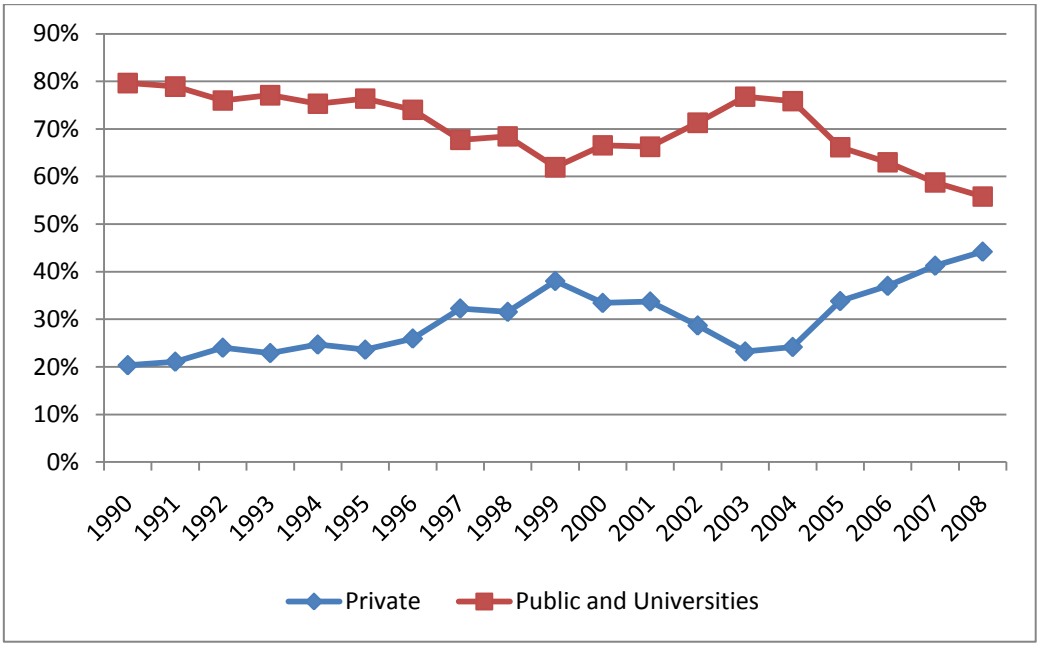
One factor enabling rapid outcomes through the said policies was the government's supporting large family businesses and neglecting some problems about these firms. This way, family businesses having substantial amounts of financial resources were directed to risky and costly projects tailored to develop domestic R&D. While it was almost only the large firms that carried out private sector R&D with the help of substantial support from the government until the 1997 crisis, policies implemented afterwards enabled also SMEs to increase their R&D activities. After the crisis, public R&D funds were channeled particularly to small technology-oriented firms and information and communication technology were supported primarily. Another factor enabling rapid outcomes in domestic R&D policies was the export oriented growth strategy. Domestic firms having trouble in competing in the international market had to invest in R&D.[8]

Thanks to the implemented policies and the triggering factors, public and private sector R&D shares went through a transformation. The said transformation has a major role in the sectoral change Korea, the rise in the share of high-technology exports and thus rapid economic growth in S. Korea. R&D activities by the private sector generate and accelerate product development and commercialization processes. Thus, newly developed products can be introduced in the international markets in a short time and the competitiveness of the private sector can be improved. Moreover, S. Korea implemented export oriented technology and product development policy. It is of critical importance for developing countries to carry out result oriented development process accompanied by a needs assessment. And this proved one of the factors that enabled rapid fruits.

Then, did Turkey go through a similar transformation process which made important and instant contributions in S. Korea? Concerning the shares of the public and the private sector in R&D, it is seen that Turkey started to go through a similar transformation taking place in 1980s in S. Korea as of 2004. The rise in the share of private sector in R&D beginning with 1990s stopped in 1999-2004 period but regained pace following 2004. Share of private sector in R&D rose from 20 percent in 1990 to 44 percent in 2008. That Turkey could achieve a transformation only two decades after S. Korea is closely related with the policy preferences and priorities. While S. Korea emphasized the importance of technology transfers beginning with 1960s, Turkey brought the issue forward particularly in the Fifth Development Plan (1985-1989). A similar trend is observed also for the subsidies for encouraging private sector R&D and for the timing of priorities.

[8] Models for National Technology and Innovation Capacity Development for Turkey, TTGV, 2009.

Figure 10. Change in the share of public and private sector in R&D in Turkey (1990-2008)



Source: TURKSTAT- R&D Data

- *S. Korea is on the way of developing an integrated innovation system; where does Turkey stand?*

One other factor that comes to fore in the assessment of the development of R&D system and the contribution it made to S. Korea's economy is the intensity of development activities[9]. When R&D processes are examined in the context of basic research, applied research and development; it is seen that development activities constitute 65 percent of overall R&D in S. Korea. S. Korea allocates a smaller share for basic research then developed countries including USA and Japan.

The general trend is that a country invests more on basic research as it gets more prosperous.[10] Nonetheless, the share S. Korea allocated for basic research did not increase despite economic growth. A substantial proportion of R&D expenditures is allocated for development and applied research in tandem with the interests of the private sector. But in recent years with the completion of the imitation and transformation process and getting halfway through the innovation process, policies targeting to increase basic research have gained ground with the aim to establish an integrated innovation system and secure sustainable economic growth. Among the priorities of the state is introducing subsidies tailored for increasing basic research in universities and public research institutes whereas the private sector seeks to develop innovative products and processes by all means to protect and extend its competitiveness. This demand by the private sector requires basic research alongside with applied research and development processes. Therefore, in the recent years efforts to concentrate on basic research has increased also across the private sector. Moreover, firms expect universities to conduct such research on their behalf. However since graduate programs of

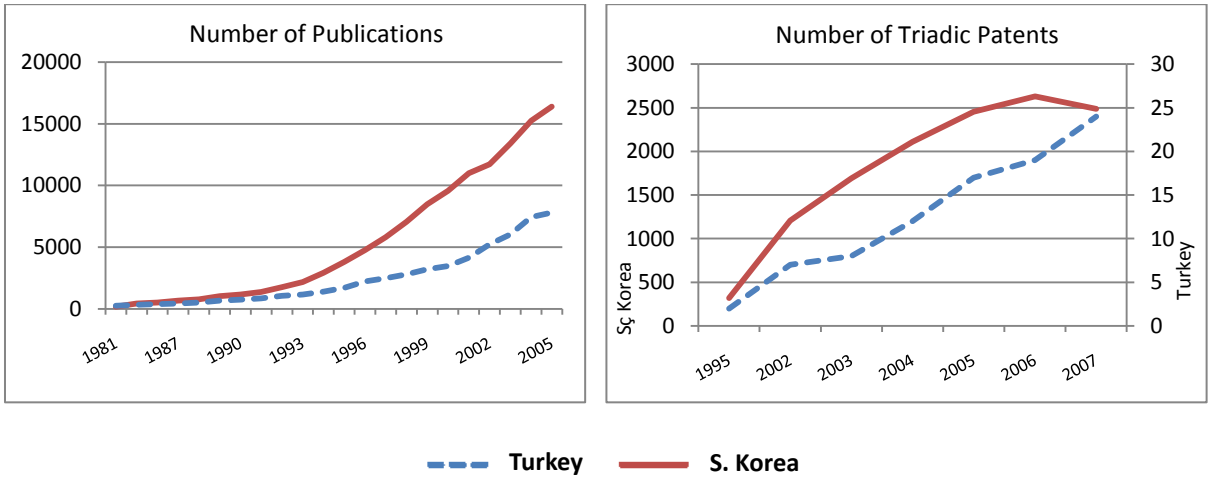
[9] R&D activities involve three different stages with respect to the quality and scope of activities: basic research, applied research and development. The third one refers to systematic efforts aiming to develop a product/process/service on the basis of the knowledge obtained from research and applied research experiences.

[10] Models for National Technology and Innovation Capacity Development for Turkey, TTGV, 2009

universities are not matured, basic research capacity of Korean universities is weak. In the recent years policies to overcome this are prioritized and funds allocated for universities are raised.

Turkey allocates only 17 percent of R&D expenditures to development activities.[11] On the other hand, the share of basic research is quite higher than Korea as well as some developed countries. Turkey's and S. Korea's performances are similar concerning number of publications whereas the latter outperforms concerning number of patents. Although the share of basic research which is recently highlighted by S. Korea in an effort to increase the share in overall R&D is high in Turkey, there exists no R&D chain infrastructure which such research will form the basis of. S. Korea has always attached importance to the establishment of the R&D structure and improvement of product development and commercialization process and after realizing these via different processes have begun supporting basic research which will serve as a basis to the integrated innovation system. Nonetheless, Turkey never had such a priority and therefore number of patents is low compared to S. Korea in spite of a similar performance in terms of publications. Turkey yet does not have a mature system which functions to support a product development and product commercialization process directly associated with the industry and fed by conducted research and publications. Despite that established recently in S. Korea, the system in Turkey is not integrated and the country suffers from a design problem due to the mismatch of science, technology and industrial policies.

Figure 11. Number of publications and patents, Turkey and S. Korea



Source: OECD Patent Database and OECD Main Science and Technology Indicators 2008.

S. Korea has increased the support for basic research with the aim to establish an integrated innovation structure particularly over the last decade and targets to extend domestic basic research activities that can feed the system with inputs. The problem Turkey suffers in this regard is the absence of an integrated system through which the results of the existing research can be utilized. Therefore, in the coming period, Turkey's priority should be establishing an integrated system to create value added through R&D.

[11] TUBITAK Statistics, 2010

- *An important factor enabling S. Korea's leap forward in high technology sectors: Target sector selection*

Another factor that contributed to S. Korea's high pace in development contest through technological structuring and development was that R&D policies were implemented with strategic decisions in selected target sectors. As also mentioned in the context of sectoral changes, the importance attached to ICT after the crisis is a good example to this practice.[12] Policies tailored for target sectors can give quicker results. Similarly in S. Korea ICT sector has experienced a major breakthrough in terms of exports and competitiveness. It is also observed that recently effort is made to monitor developments in the world closely and increase investments in and attach strategic priority to the nanotechnology and biotechnology sectors.

Conclusion

This study examined the changes in the industrial strategy and science and technology policies in S. Korea and discussed that the advance of the R&D system plays a crucial role in the sectoral change and rapid economic growth of S. Korea. The note also underlined some factors which ensured rapid translation of the development in R&D activities into sectoral change and economic development.

- Industrial strategy of S. Korea and R&D advancement processes were examined under three processes: imitation, transformation and innovation. The transformation process S. Korea went through in 1980s and the current process in Turkey are similar in many dimensions:
    - S. Korea focused on labor intensive and low-technology sectors in 1960s and switched rapidly to technology intensive sectors in 1970s and 1980s. In Turkey the shift from labor intensive and low technology to technology intensive sectors took place rapidly beginning only with early 2000s.
    - In the period between 1960 and 1980 named as the imitation process, technology transfers were predominant in S. Korea while beginning with 1980s improving the R&D capacity was a priority area. In Turkey, the importance of technology transfers was highlighted in late 1980s and improvement of national R&D capacity was highlighted in early 2000s.
    - Significant discrepancies are observed in the implementation of export oriented industrialization strategy which was launched with a similar timing in Turkey and in S. Korea. In S. Korea this process was accompanied with efforts to change the export composition and to switch to technology intensive sectors. The technological content of the export goods indicate that medium-technology products gained dominance in S. Korea in 1990s whereas in Turkey share of medium technology exports converged to that of low-technology exports only in recent years. Share of high-technology exports in Turkey is currently at a level similar to that S. Korea achieved in 1980s.[13]

[12] OECD Reviews of Innovation Policy, Korea (2009)

[13] Models for National Technology and Innovation Capacity Development for Turkey, TTGV, 2009

    - Analysis of the composition of R&D expenditures by public and private sector reveals that the transformation S. Korea experienced in 1980s took place in Turkey particularly after 2004.

- With the transformation S. Korea experienced in 1980, private sector started to carry out a substantial proportion of R&D, which by facilitating product development and commercialization, contributed to the international competitiveness of the private sector. Furthermore, in S. Korea development activities constitute a large proportion of overall R&D activities which accelerates the introduction of new products to the market. In the recent years policy focus in S. Korea has shifted towards turning the R&D system into an integrated innovation system and expanding basic research to secure the sustainability of economic growth. In Turkey, on the other hand, while the share of basic research has always been relatively higher, there is no R&D chain structure which such research can serve as a basis for. Number of publications made as a result of basic academic research is similar to S. Korea whereas the number of patents is lower in Turkey. Turkey yet does not have a mature system which functions to support a product development and product commercialization process directly associated with the industry and fed by conducted research and publications. R&D ensures high value added as far as it can be commercialized. Therefore, private sector R&D development and following establishment of an integrated innovation system in S. Korea can serve as an example model for Turkey.
- One of the most prominent factors that accelerate economic growth and development in developing countries is technology, product and process development in tandem with needs. This phenomenon can be observed in S. Korea in practice. Particularly beginning with 1990s, S. Korea implemented policies encouraging research in line with the needs of the country and the industry. Thus, it is of great importance for Turkey to address such policies in this context of university-industry cooperation.
- Another factor that contributed to S. Korea's high pace in development contest through technological structuring and development was that R&D policies were implemented with strategic decisions in selected target sectors. Policies tailored for target sectors can give quicker results. Major breakthrough S. Korean ICT sector has experienced in terms of exports and competitiveness is an example to this. It is also observed that recently effort is made to monitor developments in the world closely and increase investments in and attach strategic priority to the nanotechnology and biotechnology sectors.

It is no more possible for Turkey to protect and improve its international competitiveness by pursuing strategies based on cheap labor and labor-intensive export sectors. It is of significant importance to switch from low-technology to medium- and high-technology production for Turkey to make a leap in the global market and sustain competitiveness. To this end, Turkey has to carry out sectoral change and alter the export composition. The crucial importance of these strategies also to avoid the 'medium-income trap' is evident. S. Korea's experience in this process must be assessed taking unique conditions facing Turkey into account and the transformation process must be accelerated.